INDIAN INSTITUTE OF TECHNOLOGY, KHARAGPUR

Date: _____ FN/AN, Time: 2 hours, Full Marks: 60, Department: E & ECE
Number of Students 223 Mid Spring Semester Examination 2012-13
Subject No. EC 21008 Subject name: **Analog Electronic Circuits**
2nd year B. Tech.

Instruction: Answer *ALL* questions and in the **same order** as they appear in the question paper. Answers to various parts of a question must be **together**.
Wherever necessary, you may make assumption(s) with reasonable justification.

Given: Saturation region drain current of an enhancement mode MOS transistor is

$$|I_{DS}| = K\,(|V_{GS}| - |V_{Th}|)^2\,(1 + \lambda |V_{DS}|)$$

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1. (a) When a cascade of two identical amplifiers is being driven by a signal generator having an open circuit output voltage of 5 mV and a source resistance of 600 Ω, the combined amplifier develops an output of 5.4 V across a 25 Ω load. Find the input resistance of the amplifier, if it is known that the individual amplifiers are having an inherent voltage gain of 100 and an input resistance of 100 Ω.

   (b) Find out the inherent transconductance, inherent transresistance and inherent current gain of an individual amplifier as specified in part (a) of this question.

   (9+6)

2. A common emitter amplifier circuit is shown in Fig. 1. The supply voltage is 12V. For the transistor, it is given that, the β is equal to 99, $V_{BE(on)} = 0.67$ V and $V_{CE(sat)} = 0.27$ V.

   (a) Assuming the transistor is in active region of operation, calculate the value of its collector current. Calculate the value of R_C so that the output signal swing is ±5.7V.

   (b) With the switch at "closed" condition, find the voltage gain (in mid-frequency range), the lower cut-off and the upper cut-off frequencies of the frequency response of the amplifier.

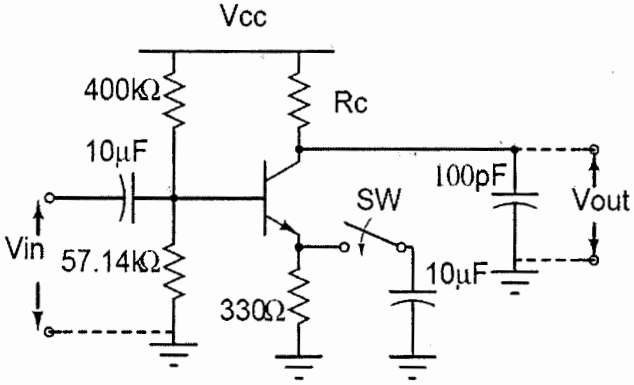

Fig. 1: Common emitter amplifier

   (c) With the switch at "open" condition, find the voltage gain (in mid-frequency range) and the lower cut-off frequency of the frequency response of the amplifier.

   (5+5+5)

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3. Consider the circuit shown in Fig. 2 and find out the input resistance, the output resistance, and maximum possible undistorted sinusoidal output swing for each of the following cases (assume that the capacitors are having very high capacitance, β of the transistor is 200):

(a) Terminal X is grounded, input is applied at terminal Y and output is taken from terminal Z.

(b) Terminal Y is grounded, input is applied at terminal X and output is taken from terminal Z.

(c) Terminal Z is grounded, input is applied at terminal X and output is taken from terminal Y.

(5+5+5)

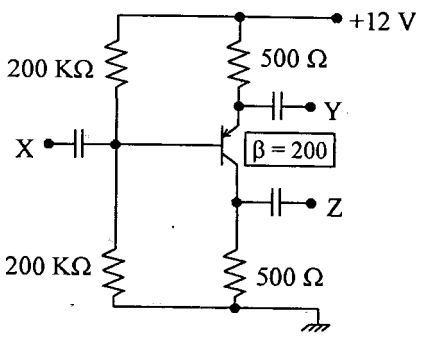

Fig. 2 : Amplifier circuit

4. A common source amplifier circuit is shown in Fig. 3. Values of different parameters of the transistor are the following: Threshold voltage $V_{Th} = -1.7V$, transconductance factor $K = 3mA/V^2$, assume channel length modulation is very small.

(a) Assuming the transistor is in the saturation region of operation, find the value of its source to drain quiescent current. What is the maximum value of R_D so that the transistor remains in the saturation region of operation?

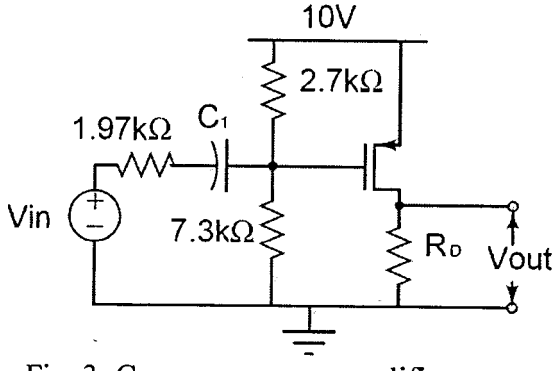

Fig. 3: Common source amplifier

(b) Draw the small signal equivalent circuit (including C_{gs} and C_{gd} of the transistor) of the amplifier and derive expressions of the lower- and the upper cut-off frequencies of the amplifier.

(c) Consider the following values of different parameters: R_D is equal to half of the maximum value obtained in part (a) of this question, C_1=10 μF, C_{gs}=10 pF, C_{gd}=1 pF. What is the output voltage for an input of $1 + 0.1sin(2000\,\pi t)$ Volts?

(5+5+5)

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